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Review Article

Phytochemistry And Pharmacological Studies Of Cassia Angustifolia: A Medicinal Plant Review

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ABSTRACT

Cassia angustifolia also known as senna is a pharmacologically crucial plant. Several studies have been performed to evaluate the pharmacological potential of various plant parts, including leaves, flowers, seeds, and the plant itself, for antibacterial, anticancer, antioxidant, antiacne, and other activities. The chemical composition, solubility, bioavailability, and amount of such phytoconstituents have an effect on their antibacterial, anti-inflammatory, and antioxidative properties. The aim of this research is to provide a comprehensive description of its phytochemistry, specifics on the phytochemicals existing in various parts of the plant, and discoveries and projections of its probable pharmacological effects. Herbs and herbal remedies are more beneficial at treating a number of disorders and have fewer side effects than allopathic therapies. Cassia leaves and pods have been used for traditional or herbal medicine since ancient times. Throughout literature study was done using several online platforms, such as Google Scholar, PubMed, Science Direct, and Springer.

INTRODUCTION

Cassia angustifolia is a well-known traditional Indian plant that belongs to the Leguminosae family. It also known as Alexandrian senna. [1] The genus Cassia containing approximately 500 species of flowering plants,3 including Cassia angustifolia Vahl., which is widely used medicinally. [2] Cassia angustifolia i.e. senna found in various state of India including Andhra Pradesh and Karnataka, Pune (Maharashtra), Gujarat (Anand and Mehsana), Rajasthan

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(Kodhpur), Delhi and dry coastal districts of Tamil Nadu. [3] This plant typically grows to a height of 0.5 to 2 meters long, spreading branches. Its leaves are complex and feathery, with long oval-shaped leaflets. [4] The flowers are yellow and blossom in clusters, while the pods are greenish-brown, measuring 0.8 to 1.4 cm in width, containing smooth brown seeds inside. [5] This plant is utilized in various traditional medicinal systems such as Homeopathy, Ayurveda, Unani, and Sidha for treating conditions like constipation, indigestion, and hepatoprotective etc. [6] Its use as a folk remedy for multiple ailments has been documented globally, highlighting the need for further research to identify the compounds responsible for its therapeutic effects. In elderly patients, it is commonly employed as a laxative. The primary active component, sennoside, acts as a prodrug that is processed in the large intestine.[7] The medicinal properties of the leaves and pods include sennosides, rhein, aloe-amine, kaempferein, and iso-rhein. [8] This plant is versatile, thriving in various environments with different temperatures and climates. [9] It has a long history in traditional medicine, often used as a purgative. [10] Ayurvedic texts indicate that this botanical remedy can help reduce kapha and vata in the body. [11] Cassia angustifolia, recognized as a non-prescription treatment for constipation, has received approval from the Food and Drug Administration (FDA) in the United States. [12] In Unani medicine, the leaves of Cassia angustifolia are commonly utilized to address conditions like constipation, asthma, and skin and joint diseases. It helps balance the three humours Safr yellow bile, Sawda black bile, and balgham phlegm by eliminating morbid humours, thus acting as a detoxifying agent to alleviate pathological conditions. [13-15]

Synonyms of Cassia angustifolia [16]

English: Indian Senna, Tinnevelly Senna
Hindi: Sana ka pat
Sanskrit: Svarnapatri
Telugu: Nela tangedu
Malayalam: Sunnamukhi, Connamukki
Kannada: Nelavarika sonamukhi
Tamil: Nilavarai, Nelavakai

Table No.1: Taxonomical Classification of Cassia angustifolia [17]

Kingdom	Plantate
Subkingdom	Viridiplanae- green plant
Subdivision	Spermatophyta
Division	Magnoliopsida
Class	Magnoliopsida
Subclass	Rosidae
Order	Fabales
Family	Leguminoceae/ Fabaceae
Sub Family	Caesalpinoideae
Genus	Cassia
Species	Angustifolia
Botanical name	Cassia angustifolia

Fig 1. Cassia angustifolia plant

PHYTOCHEMICAL CONSTITUENTS

Table No: 2 Physicochemical Standards of the leaves and Seeds of Cassia angustifolia [18,19]

Parameter	Leaves	Seeds
Moisture content (%)	1.9	89.05
Total ash (%)	11.2	4.2
Acid insoluble ash (%)	1.5	0.20
Alcohol soluble extractive value (%)	3.8	9.4
Water soluble extractive value (%)	16.5	32.4

Leaves:

The leaves are slender and grayish-green, featuring 5 to 8 pairs of oval-lanceolate leaflets measuring 2.5 cm by 1.5 cm. This plant produces medium-sized pods. [20] The leaflets have short, sturdy petioles that are rarely damaged. They range from approximately 1.5 to 6.0 cm in length and 0.5 to 1.5 cm in width, exhibiting a distinctive odor and a mucilage-like, slightly bitter taste. [21-22] Both surfaces of the leaflets are glabrous and hairy. They possess a lanceolate to ovate shape, a complete blade, a smooth surface, a sharp apex, a cuneate base, and a color that varies from green to yellow-green. [23] The leaves and pods of Cassia angustifolia are employed as an anti-helminthic by preparing a decoction powder to treat intestinal worms. Additionally, they are frequently used as an antipyretic for conditions such as typhoid, splenic enlargement, cholera, as well as for managing anemia, toxicity, and genotoxicity associated with Escherichia coli. [24]

Seeds:

Cassia angustifolia produces medium-sized pods. [25] The seeds are flat, ranging in color from yellowish to ceramic-brown, and are wedge-shaped, featuring lateral ridges and furrows on their surface, along with a noticeable hilum, micropyle, and raphe. The pods are typically slightly curved, cylindrical, or often irregularly shaped. They are green when young and turn brown as they mature. [26] The hilum is long and oval, displaying a scar along the edge; the micropyle is small, and the raphe is ridged on the side opposite the micropyle, extending in an arc. The fruit is a glabrous, dehiscent pod measuring 4 to 6 cm in length and containing approximately 10 to 17 seeds.[27]

Flowers:

The flowering period occurs from July to September, featuring large yellow flowers. [28] The flowers are of type 5, with free, slightly zygomorphic parts; the pedicels measure 3 to 4 cm in length and are arranged in terminal or axillary racemes that can reach up to 15 cm. The sepals are

slightly irregular, yellow-green, measuring 10 to 13 mm long and 6 to 9 mm wide. The petals are yellow and somewhat uneven, ranging from 14 to 17 mm in length and 7 to 10 mm in width. [29] There are 10 free stamens, and the ovary is hairy and stipitate. Blooming occurs from April to June. The fruit consists of a dehiscent, sparsely hairy pod that is 5 to 6 cm long and 1.7 to 2.3 cm wide, slightly curved, and containing approximately 10 seeds. As the fruit matures, it turns black. The flowers are yellow, arranged in terminal racemes measuring 10 to 15 cm in length and containing 7 to 12 flowers. [30]

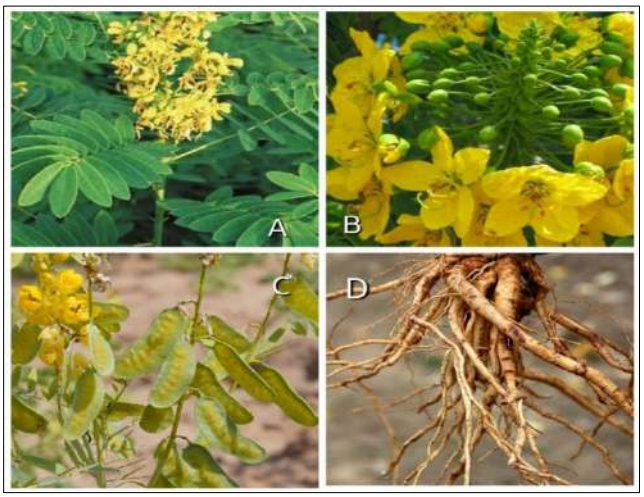
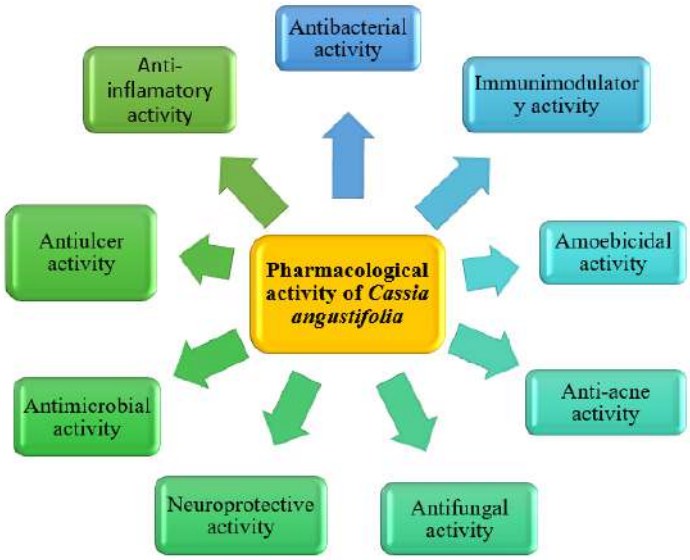


Fig 2: Morphological description of Cassia angustifolia (A-Leaves, B-Flowers, C- pods, D- Roots)

Table No: 3 Phytoconstituents present in different parts of plant Cassia angustifolia [31-35]

Part of plant	Chemical compositions
Roots	Physcion, stigmasterol, Betulinic acid, Chrysophanol, Physcion, 1- hydroxy-7-methoxy-3-methyl-anthraquinone, 8-O-methylchrysophanol, 1-Omethylchrysophanol and aloe-emodin.
Seeds	**Anthraquinones-** chryso-obtusin, Obtusin, chrysoobtusin-2-O-beta-D-glucoside, emodin, chrysophanol, obtusifolin, obtusifolin-2-O-beta-D-glucoside, alaternin 2- O-Dglucopyranoside, physcion, aurantio-obtusin. **Brassinosteroids** (brassinolide, castasterone, typhasterol, teasterone, and 28-norcastasterone) **monoglycerides** **Phenolic glycosides** such as rubrofusarin triglucoside, torachrysone gentiobioside, torachrysone tetraglucoside and torachrysone apioglucoside, nor-rubrofusarin gentiobioside, demethylflavasperone gentiobioside etc.
Stem bark	emodin and β-sitosterol, anthraquinone, 1- hydroxy-5-methoxy-2-methyl anthraquinone and its glycoside, 5-methoxy-2-methyl anthraquinone-1-O-α-L-rhamnoside along with chrysophanol, d-mannitol, myricyl alcohol, β-sitosterol, glucose, tigonelline, 1-stachydnine and choline. marginic and palmitic acids ethyl arachidate and behenic acids, euphol, aurapterol, basseol, rhein, 3, 5, 8, 3′4′5′- hexahydroxy flavones
Leaves	**Anthraquinone glycoside -** rhein, emodine, physion, chrysophanol (marker), Obtusin, chryso-obtusin, chryso-obtusin-2-O-β-D-glucoside, obtusifolin and chryso-obtusifolin-2-O- β -D glucoside. **Flavonoids** -quarcitin, kameferol, quercimeritrin, scutellarein, and rutin.
Flowers	rhein-8-glucoside, quercetin napthalene glycosides, rhein-8-diglucoside, rhein etc.

PHARMACOLOGICAL ACTIVITIES



Antibacterial activity:

Sayantan Raha and Bhaskar Narayan Chaudhari investigated the antibacterial properties of the plant Cassia angustifolia. Their study assessed the antibacterial effects of an ethanolic extract of C. angustifolia leaves against multi-drug resistant (MDR) microorganisms. The results indicated that the leaf extracts exhibit significant antibacterial activity against all tested MDR strains. The phytochemicals present in the plant, including tannins, saponins, flavonoids, alkaloids, steroids, and quinones, may contribute to these antibacterial effects. These findings suggest that Indian Senna could be a potential source for developing new antibiotics to combat resistant bacterial infections. [36]

Immunomodulatory:

Bagwe, A., and Bangi, S. examined the immunomodulatory effects of C. angustifolia leaves using a 100% methanol extract. Their research demonstrated that Cassia angustifolia Vahl has immunomodulatory properties in albino mice that were immunosuppressed by cyclophosphamide. Immunostimulatory agents enhance the body's immune response to diseases by activating the immune system. In this study, total and differential leukocyte counts were conducted to assess the impact of the plant extract on the hematological system in an animal model. The results indicate that the crude methanolic leaf extract of C. angustifolia enhances both cell-mediated and humoral immune responses in immunocompromised mice. [37]

Amoebicidal activity:

Rachasak Boonhok and Suthinee Sangkanu reported that Cassia angustifolia exhibits amoebicidal activity. The extract of C. angustifolia inhibited the growth of Acanthamoeba triangularis trophozoites at micromolar concentrations. Scanning electron microscopy (SEM) images showed morphological changes in the trophozoites, such as the formation of holes in the cell membrane and membrane rupture. In addition to its amoebicidal effects, the extract influenced surviving trophozoites, leading to cyst formation and vacuolization observed under a microscope, as well as changes in the transcriptional expression related to Acanthamoeba autophagy. These findings demonstrate the anti-Acanthamoeba activity of C. angustifolia extract and highlight the autophagic response in surviving trophozoites under the influence of the plant extract, along with evidence of cyst formation. [38]

Antiacne activity:

Ishika Mishra, B. K. Dubey, and Deepak Basedia noted that P. acnes, the main pathogenic microbe, along with M. furfur (yeast) and S. epidermidis, are frequently present in acne lesions. Consequently, the researchers selected the ethanolic extract of C. angustifolia to investigate its anti-acne properties. Phytochemical screening of Cassia angustifolia revealed the presence of flavonoids, proteins, alkaloids, saponins, and diterpenes in the ethanol extracts. [39]

Antifungal activity:

Megha Das Adhikary and Bhaskar Narayan Chaudhur investigated the antifungal properties of the plant Cassia angustifolia. Indian senna contains various compounds, including flavonoids, pinnitolos (polyols), acidic polysaccharides, and minerals. Additionally, sennosides A and B, along with other substances such as myricyl alcohol, anthraquinone derivatives, galactose, arabinose, rhamnose, galacturonic acid, chrysophanic acid, salicylic acid, resin, and mannitol, contribute to its antifungal activity. The antifungal efficacy of the extract was evaluated against several fungal strains, including Candida albicans (ATCC10231), Candida parapsilosis, and Candida auris. The results indicated that the leaf extract of Cassia angustifolia exhibited significant antifungal activity against all tested strains. [40]

Neuroprotective activity:

Pragati Khare and Dipali Gupta studied the neuroprotective effects of the ethanolic extract of Cassia angustifolia. The extract significantly reduced the levels of transfer latency in the raised plus maze and Morri's water maze tests. Additionally, it resulted in noticeably longer latency in the passive avoidance paradigm. The study found significant increases in acetylcholinesterase and GSH levels ($P < 0.001$), while total protein, NO, and MDA levels significantly decreased ($P < 0.001$). These findings demonstrate that the ethanolic leaf extract of C. angustifolia offers protection against memory loss induced by colchicine. [41]

Antimicrobial activity:

Parul Sood studied the antimicrobial properties of leaf extracts from the plant Cassia angustifolia against various bacterial strains, including Escherichia coli, Staphylococcus aureus, and Bacillus subtilis, as well as fungal strains such as Aspergillus niger and Candida albicans. The comparative study indicated that the ethanolic extract prepared from the sample SR-2 was the most effective against all tested microbial strains. [42]

Antiulcer:

P.K. Mohanty investigated the antiulcer properties of the methanolic extract of Cassia angustifolia bark, comparing its effects with Ranitidine in Shay rats. The study demonstrated complete inhibition of ulceration and a significant reduction in free acidity associated with the bark extract. Additionally, the total acidity, peptic activity, and volume of gastric juice secreted were assessed. [43]

Anti-inflammatory activity:

Vivek Chourasia investigated the anti-inflammatory properties of Cassia angustifolia using a methanolic seed extract. The anti-inflammatory activity was evaluated through a carrageenan-induced rat paw edema assay, revealing significant effects attributed to the presence of triterpenoid glycosides and carbohydrates. During the proliferative phase, the seeds of Cassia angustifolia demonstrated a notable reduction in inflammation, as evidenced by decreased granuloma formation in the cotton pellet-induced granuloma model in rats. The methanolic extract of the seeds also significantly reduced the generation of fibroblasts and suppressed mucopolysaccharides and collagen fibers. [44]

Sr. No.	Plant Part Used	Solvent Used for Extraction	Extract Type	Identified Phytochemicals	Isolated Phytoconstituents	Pharmacological Activity	Proposed Mechanism of Action	Study Insights	Citation with Hyperlink
1	Leaf	Ethanol	Ethanolic Extract	Resin, Phenol, Coumarins, Alkaloids, Saponin, Steroid	Sennosides A and B	Antibacterial	Cell wall disruption	Significant activity against drug-resistant bacteria. Potential for new antibiotic development.	[36]
2	Leaf	Absolute methanol	Methanolic extract	alkaloids, phenolics, flavonoids, phytosterols, tannins and micronutrients such as iron, manganese, calcium, magnesium, zinc, copper, sodium, potassium, vitamin E, etc	Not specified	Immunomodulatory	In immunosuppressed animals, it stimulates both cellular and humoral immune responses.	Responsible for immunomodulation	[37]
3	Leaf	Ethanol	Ethanolic Extract	Not specified	Not specified	Amoebicidal	Disruption of cell membrane	Effective against Acanthamoeba triangularis, causing morphological changes and autophagic response in surviving trophozoites.	[38]
4	Leaf	Ethanol	Ethanolic Extract	Flavonoid, Proteins, Alkaloids, Saponins, Diterpenes	Quercetin	Anti-acne	Inhibition of inflammatory mediators	Reduction in ear thickness and inflammation in acne models. Presence of bioactive compounds contributing to anti-acne properties.	[39]
5	Leaf	Ethanol	Ethanolic Extract	Flavonoids, Pinitols, Acidic Polysaccharides, Minerals	Sennosides A and B, Myricyl alcohol	Antifungal	Disruption of fungal cell membranes	Significant antifungal activity against Candida species, potential for developing treatments for resistant fungal infections.	[40]

6	Leaf	Ethanol, Petroleum ether	Ethanolic Extract	Sennosides C and D, Napthalene glycosides like tinnevellin glycoside and 6-hydroxy musizin glycoside, flavonoid (kaempferol)	Not specified	Neuroprotective	Acetylcholinesterase and GSH levels have significantly increased, protecting against memory loss. brought on by colchicine.	Neuroprotective effect and study on cognitive disfunction	[41]
7	Leaf	Ethanol	Ethanolic Extract	Not specified	Not specified	Antimicrobial	Zone of resistance against all tested microbial strains.	Responsible for antimicrobial activity need further study	[42]
8	Bark	Methanol	Methanolic extract	Not specified	Not specified	Antiulcer	Ulceration was inhibited, and there was a significant reduction in free acidity, total acidity, peptic activity, and gastric juice secretion.	Extract gives similar degree of protection against ulcerations given by 2mg/kg and 5mg/kg of ranitidine	[43]
9	Seeds	Methanol, pet. Ether, water	Methanolic extract, pet. Ether, aqueous extract	Anthraquinone glycosides, Steroids, tri-terpenoid glycosides, carbohydrates,	Triterpenoid glycosides	Anti-inflammatory	Reduced granuloma formation in cotton pellet-induced granuloma, considerable decrease in inhibiting the creation of collagen fibers, fibroblasts, and suppressing mucopolysaccharide.	Anti-inflammatory activity of seeds by decrease granuloma formation.	[44]

TRADITIONAL USES

Cassia angustifolia has historical pharmacological uses, physicians chose to utilize it as an herbal medication. [45], [46] C angustifolia has been utilized to treat epilepsy, piles, skin infections, respiratory disorders, heart problems, and migraines. [47] Many earlier investigations have explored Cassia's pharmacological ability and its importance in medical benefits, including antibacterial and antifungal effects.[48], [49] In Iraq, Cassia leaf is taken to treat hemorrhoids and as a laxative. [50] Cassia species are famous by using different part of plant which includes root, leaves and seeds, bark in medical purpose. And the previous studies were proven contain several compounds as pheolic, flavonoid, naphthopyrone glycosides, which have medicinal properties such as hepatoprotective, antimutagenic, anti-inflammatory, antioxidant, antibacterial and antifungal activity. [51] Cassia has alkaloid compound that showed antibacterial activity. [52] and antioxidant ability [53], phytochemical component of Cassia was indicated has sennoside A act as laxative, rhein act as antibiotic and sitosterol act as anti-cancer. [54]

CONCLUSION AND FUTURE PRESPECTIVES

In today's world, the use of herbal medicine is becoming more popular as an alternative method of treating diseases that have no solution in contemporary medicine or are associated with a risk of negative effects. In Unani Medicine, ailments are treated with herbal medications such as Senna leaves. The present review investigated that traditional medicinal uses, phytochemical profile and pharmacological properties of Cassia angustifolia. The retrieved data documented that Cassia angustifolia is a good source of diverse phytoconstituents and has tremendous therapeutic properties. Major reported constituents of the plant are flavonoids, sennosides A, sennoside B, glycosides, tannins, saponins, alkaloids, triterpenoids and phenolic compounds. The work review substantiated most of the traditional claims on the health benefits. But as seen during literature search it was found that major work has been need for future investigations to isolate and characterized pharmacological active agents that confer medicinal properties on Cassia angustifolia.

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CONFLICTS INTERSTS

The authors declare no conflicts of interest.

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